

## LOGGING COSTS FOR A TRIAL OF INTENSIVE RESIDUE REMOVAL

by

Thomas C. Adams, *Economist*

### Abstract

Logging costs were developed in a study of residue removal to specified levels in each of three size classes: 1/4 to 3, 3.1 to 9, and over 9 inches in diameter. These levels were determined by an interdisciplinary team during initial sale planning and represented levels that would be desired to attain without slash burning. Cable yarding was specified. This trial was conducted on the Wind River Experimental Forest near Carson, Washington.

KEYWORDS: Logging enterprise costs, residue management, intensive management.

## INTRODUCTION

Forest managers are seeking ways to reduce the need for broadcast slash burning. Residue removal is one alternative. Accordingly, a trial of intensive residue removal was conducted on the Wind River Experimental Forest, Gifford Pinchot National Forest, near Carson, Washington, during 1975-77. This trial was on three clearcut units of the Trout Creek Hill timber sale, at about 1,800-foot elevation, in old-growth western hemlock, Douglas-fir, and Pacific silver fir (fig. 1).

The purpose of this trial was to test the practicability of residue-level prescription by an interdisciplinary team, with the timber sale purchaser responsible for achieving the desired end result. This note covers production rates and logging costs for the three levels of residue removal tested. Residue management aspects of this timber sale are reported in another research note.<sup>1</sup>

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<sup>1</sup>Thomas C. Adams, Managing logging residue under the timber sale contract. USDA For. Serv. Res. Note PNW-348, Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.



Figure 1.--High-lead tower yarding to residue pile on Unit 1, Trout Creek Hill timber sale.

## TIMBER SALE SPECIFICATIONS

### Yarding Specifications

Three residue levels were specified, one on each of three clearcut units of this sale. The residue level selected for Unit 2 was determined by an interdisciplinary team who examined the area during sale preparation. Residue specifications for Unit 1 were set at approximately 30 percent less than on Unit 2, and for Unit 3 about 30 percent more (table 1). The specified residue levels were to be met through cable yarding, without burning.

Table 1--Specified and actual residue levels by diameter class  
(actual residue levels after logging shown in parentheses)

Cutting unit	Diameter class (inches)			
	1/4-3	3.1-9	Over 9	Total
	<u>Tons per acre</u>			
1	4-6 (5.6)	4-8 (2.9)	0 (0)	8-14 (8.5)
2	5-9 <u>1/</u> (9.1)	6-11 (5.2)	<10 (4.4)	<30 (18.6)
3	8-13 (8.5)	8-14 (8.4)	<20 (9.3)	<47 (26.2)

1/Actual residue level of 9.1 tons per acre was not a meaningful deviation from the specified level.

## Residue Measurement

The timber sale contract specified that the Forest Service would measure residue levels frequently, with volume of residue on each sampling area required to be under the maximum amount specified, for each of the three size classes 1/4 to 3, 3.1 to 9, and over 9 inches in diameter. No rearrangement of residue was required if minimum specified levels were not met, as in the 3.1 to 9-inch diameter class in two cutting units.

Residue volumes were measured by the planar intersect method and calculated in both cubic feet and tons per acre.<sup>2</sup> All weights represent oven-dry tons.

## RESULTS

Yarding was by the high-lead cable system. Most of the initial yarding was with a 90- or 100-foot tower; later a smaller yarder with a 70-foot tower was used for some of the yarding.

After trying several methods of yarding tops and small residue concurrently with regular yarding of merchantable logs, the operator shifted to two-stage yarding, with cull logs and other residue material yarded in a separate second stage. Some of the large cull logs were yarded during the first stage.

Tops were mostly broken up in felling or during the first-stage yarding. These and the many branches and short chunks slowed production (fig. 2). Small pieces were often choked in bundles, some of which were pre-piled to avoid delays. Much breakage occurred, however, as these bundles traveled along the ground.

Table 1 shows resulting residue levels in parentheses below each entry for the specified levels. Attained levels were generally well under the maximums allowed, chiefly because of the need to be within specified limits on each sampling unit and because extra quantities in the 3.1- to 9-inch diameter class were yarded in order to reach specified levels for the smaller material attached to those pieces.

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<sup>2</sup>Brown, James K. 1974. Handbook for inventorying downed woody material. USDA For. Serv. Gen. Tech. Rep. INT-16, 24 p., illus. Intermt. For. and Range Exp. Stn., Ogden, Utah.



Figure 2.--Two turns of residue material being yarded to piles on landing.

## Time and Production Data

Daily time sheets were prepared by the operator, showing man- and machine-hours worked on each unit. These were summarized by the two stages, main yarding and residue yarding (table 2). In this report, man-hours cover total time on the job including travel time; machine-hours include operating time minus delays over 15 minutes.<sup>3</sup> Crew size varied at times, and was generally smaller for the residue yarding stage.

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<sup>3</sup>Tractor time is shown separately for operating time and standby time when machine is available on the site but not operating. Loader machine time attributable to piling residue material and keeping landing clear was included only for the first few days on Unit 1 before the shift to two-stage yarding. Yarder and loader fixed costs are considered amortized over annual machine-hours; hence, fixed costs for these machines are not charged for delay times of more than 15 minutes.

Table 2--Man-hours and machine-hours for yarding Units 1, 2, and 3

Stage of yarding	Unit 1	Unit 2	Unit 3
		<u>Hours</u>	
<u>A. Main yarding</u>			
Man-hours:			
Straight time	2,755	3,460	3,567
Overtime	30	0	0
Machine-hours:			
100' yarder	273	126	304.5
90' yarder	186	403	283.5
70' yarder	64.5	0	0
Tractor, 180-flywheel hp:			
Standby time	244	341	0
Operating time	23.5	9	0
Tractor, 235-flywheel hp:			
Standby time	97.5	62.5	248.5
Operating time	6.5	1.5	20.5
<u>B. Residue yarding</u>			
Man-hours:			
Straight time	5,510	2,865	2,156
Overtime	115	64	70
Machine-hours:			
100' yarder	11	0	222
90' yarder	748	376.5	182.5
70' yarder	324	170	0
Loader	27	0	0
Tractor, 180-flywheel hp:			
Standby time	183.5	0	0
Operating time	7.5	0	0
Tractor, 235-flywheel hp:			
Standby time	5	70	118
Operating time	3	6	18

The three cutting units in this trial were sold on a cubic-foot basis. A total of 22,473 cunits<sup>4</sup> were removed (table 3).

Table 3--Yarding production data

Item	Unit 1	Unit 2	Unit 3	Total
<u>Cunits<sup>1/</sup></u>				
A. Scaled net volume removed	5,766	8,002	8,704	22,472
<u>Tons</u>				
B. Tons of residue yarded in residue yarding stage	4,697	3,904	3,600	12,201
<u>Tons per acre</u>				
C. Tons per acre yarded in residue yarding stage	70.1	64.0	51.4	--

<sup>1/</sup>One cunit equals 100 cubic feet.

## Yarding Costs

Per-hour yarding costs were estimated using a modification of the 1974 Bureau of Land Management Schedule 19 timber appraisal cost guide.<sup>5</sup> A factor of 1.15 was used to convert the 1974 cost data to a 1976 base. Adjusted wage rates used in this application include additions for workmen's benefits (19 percent), direct supervision (10 percent), and employer's contributions for unemployment compensation, industrial accident insurance, and social security (22 percent) (table 4).

Applying these rates to the production data of table 2 gave total costs for yarding (table 5), excluding fire protection and moving costs.

Residue yarding accounted for 65, 46, and 42 percent of total yarding cost for Units 1, 2, and 3, respectively. Residue yarding on the three units combined accounted for 53 percent of total yarding cost.

<sup>4</sup>One cunit equals 100 cubic feet.

<sup>5</sup>U.S. Bureau of Land Management. 1974. Timber appraisal production cost schedule 19, U.S. Bureau of Land Management, Oregon State Office, var. pages, illus. Portland, Oreg.

Table 4--Wage rate summary for yarding crew

Crew member	1974	1976	1976
	basic wage	basic wage	adjusted wage
	<u>Dollars per hour</u>		
Hook tender	\$5.97	\$6.87	\$10.37
Rigging slinger	5.12	5.89	8.89
Choker setters (2 x \$4.58)	9.16	10.52	15.90
Chaser	4.75	5.46	8.23
Yarder engineer	5.50	6.32	9.54
Total, 6 people	30.50	35.06	52.93
Average	5.08	5.84	8.82

Source: Developed from Bureau of Land Management Timber appraisal production cost schedule 19, U.S. Bureau of Land Management, Oregon State Office, Portland, Oreg., 1974.

Residue yarding costs per acre were estimated at \$1,365 on Unit 1, \$768 on Unit 2, and \$550 on Unit 3, with the three units together averaging \$893 per acre (table 6).

Estimated yarding costs per cunit of scaled volume removed on Unit 1 were \$8.60 for main yarding and \$15.88 for residue yarding. On Unit 3 these costs were \$6.19 for main yarding and \$4.42 for residue yarding.

Residue yarding cost per ton of residue amounted to \$19.47 on Unit 1, \$11.99 on Unit 2, and \$10.69 on Unit 3, with the three units averaging \$14.49 per ton.

From table 3 and 6, residue yarding on Unit 2 removed 12.6 more tons per acre than on Unit 3, at an extra cost of \$218 per acre, or \$17.30 per extra ton of removal. In the same fashion residue yarding on Unit 1 removed 6.1 more tons per acre than on Unit 2, at an extra cost of \$597 per acre, or \$97.87 per extra ton of removal.



Table 5--Cost of main yarding and residue yarding, Units 1, 2, and 3

Stage of yarding	1976 hourly rate <sup>1</sup> /	Unit 1	Unit 2	Unit 3
<u>Dollars</u>				
<b>A. Main yarding</b>				
Labor:				
Straight time	\$8.82 (av.)	\$24,299	\$30,517	\$31,461
Overtime	13.23	397	0	0
Total labor cost		24,696	30,517	31,461
Equipment:				
100' yarder	34.83	9,509	4,389	10,606
90' yarder	29.96	5,573	12,074	8,494
70' yarder	24.82	1,601	0	0
Tractor, 180-flywheel hp:				
Standby time	7.75	1,891	2,643	0
Operating time	23.47	552	211	0
Tractor, 235-flywheel hp:				
Standby time	10.82	1,055	676	2,689
Operating time	31.64	206	47	649
Total equipment cost		20,387	20,040	22,438
Total equipment and labor cost		45,083	50,557	53,899
Total including 10-percent overhead		49,591	55,613	53,900
<b>B. Residue yarding</b>				
Labor:				
Straight time	8.82 (av.)	48,598	25,269	19,016
Overtime	13.23	1,521	847	926
Total labor cost		50,119	26,116	19,942
Equipment:				
100' yarder	34.83	383	0	7,732
90' yarder	29.96	22,410	11,280	5,468
70' yarder	24.82	8,042	4,219	0
Loader	16.13	436	0	0
Tractor, 180-flywheel hp:				
Standby time	7.75	1,422	0	0
Operating time	23.47	176	0	0
Tractor, 235-flywheel hp:				
Standby time	10.82	54	757	1,277
Operating time	31.64	95	190	570
Total equipment cost		33,018	16,446	15,047
Total equipment and labor cost		83,137	42,562	34,989
Total including 10-percent overhead		91,451	46,818	38,488
<b>C. Total</b>		<b>\$141,042</b>	<b>\$102,431</b>	<b>\$92,388</b>

Source: Developed from Bureau of Land Management, Timber appraisal production cost schedule 19, U.S. Bureau of Land Management, Oregon State Office, Portland, Oreg., 1974. Hourly rates for yarders are estimates derived from data given for 110- and 65-ft towers.

<sup>1</sup>/Hourly equipment rates include fixed costs plus operating costs, except for tractor standby time which includes fixed costs only.

Table 6--Summary costs of main yarding and residue yarding,  
Units 1, 2, and 3<sup>1/</sup>

Item	Unit 1 67 acres	Unit 2 61 acres	Unit 3 70 acres	Total or average 198 acres
<u>Dollars</u>				
A. <u>Yarding cost</u>				
Main yarding	\$49,591	\$55,613	\$53,900	\$159,104
Residue yarding	91,451	46,818	38,488	176,757
Total	141,042	102,431	92,388	335,861
<u>Dollars per acre</u>				
B. <u>Cost per acre</u>				
Main yarding	740	912	770	804
Residue yarding	1,365	768	550	893
Total	2,105	1,680	1,320	1,697
<u>Dollars per cunit<sup>2/</sup></u>				
C. <u>Yarding cost per cunit of scaled net volume removed in main yarding</u>				
Main yarding	8.60	6.95	6.19	7.08
Residue yarding	15.88	5.85	4.42	7.87
Total	24.48	12.80	10.61	14.95
<u>Dollars per ton</u>				
D. <u>Residue yarding cost</u>				
Residue yarding	19.47	11.99	10.69	14.49

<sup>1/</sup>Attained residue levels: Unit 1 8.5 tons per acre.  
Unit 2 18.6 tons per acre.  
Unit 3 26.2 tons per acre.

<sup>2/</sup>One cunit equals 100 cubic feet.

## DISCUSSION

### Excessive Yarding Costs

The high residue yarding costs indicate that in the absence of compelling reasons to avoid burning, broadcast burning or machine piling and burning should probably be retained as a preferred alternative for this kind of site. Conventional YUM yarding<sup>6</sup> to 8-inch diameter inside bark at the large end, to 10-foot length, combined with a light spring burn of fine material could have saved a considerable amount of time and money. However, this trial was intended to provide experience and cost information applicable to situations where an alternative to burning would be desired.

### Alternative Logging Systems

The second-stage yarding costs could have been reduced with lighter equipment and a smaller crew; however, this would have required yarding all the large cull material in the first pass with the large equipment, and using a grapple skidder or some other means to keep the landing area cleared.

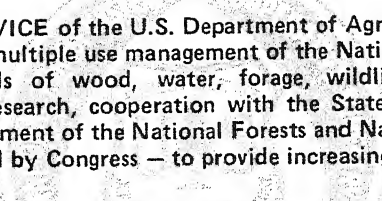
Minimum bucking-out of breaks or cull segments might have reduced yarding costs where these pieces also were yarded later; but a brief trial of tree-length yarding resulted in congestion, delays, and less efficient bucking at the landing.

## CONCLUSIONS

1. This trial of intensive residue removal by high-lead system in an old-growth forest was a rather costly procedure in relation to management goals. Additional site preparation was judged necessary for replanting on this site.
2. High costs of yarding small residue by standard high-lead equipment suggests that such equipment is not suitable for such small material.
3. In absence of a market for small residue material, some form of slash burning on this site will continue to be the favored treatment on old-growth clearcut units to reduce small residue to acceptable levels.

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<sup>6</sup>YUM yarding is an acronym for yarding of unutilized material.



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